

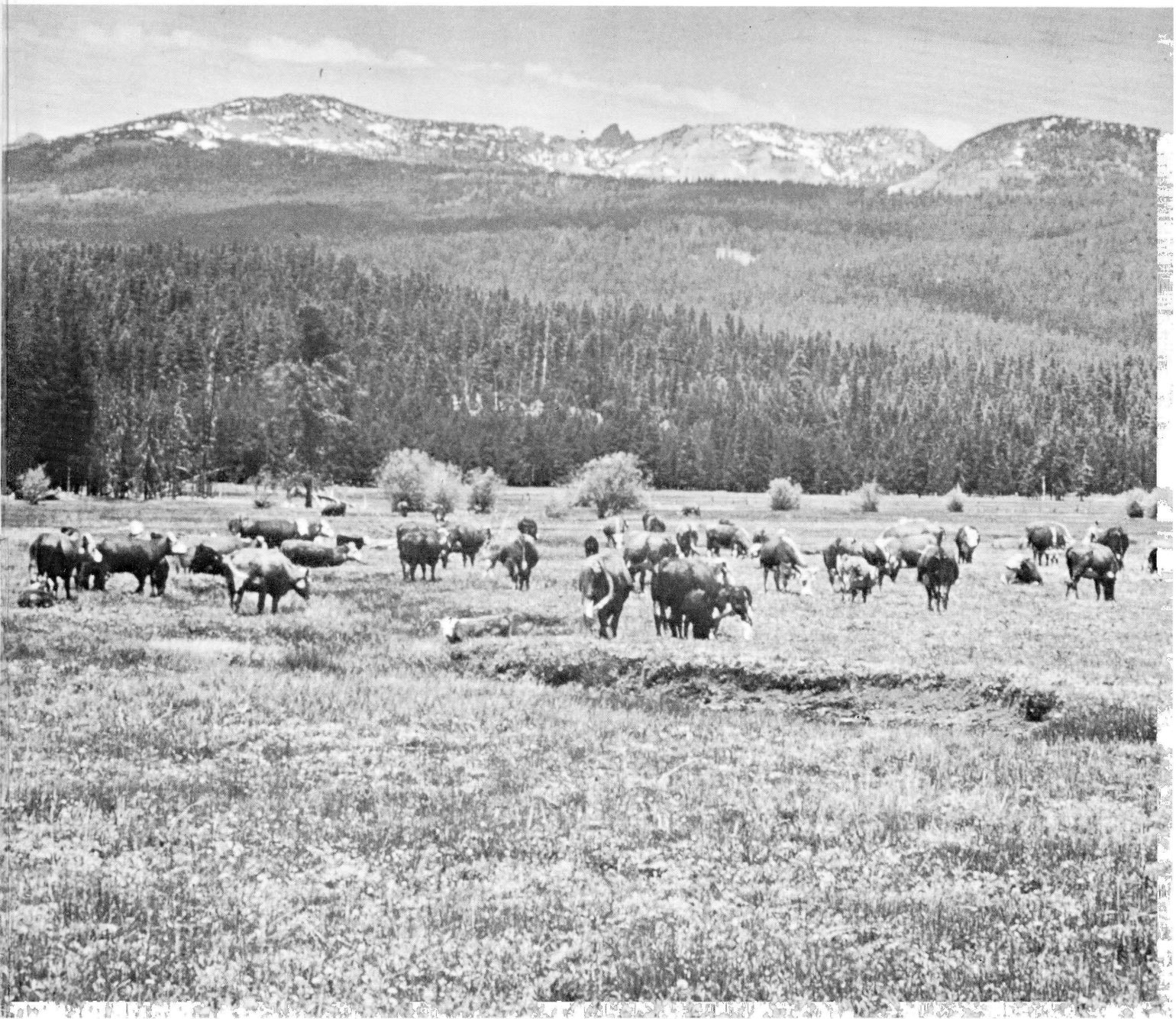
SURVEILLANCE

1965

BURNS PROJECT

Douglas-fir Tussock Moth Control

MALHEUR AND OCHOCO NATIONAL FORESTS



Cover: Cattle, under Forest Service permit, graze near
typical spray unit.

**SURVEILLANCE REPORT
1965 BURNS PROJECT
DOUGLAS—FIR TUSsock Moth CONTROL**

by
Glenn L. Crouch
Project Surveillance Coordinator
and
Randall F. Perkins
Project Director

August 1968

Insect and Disease Control Branch
Division of Timber Management
Pacific Northwest Region — Forest Service
U. S. Department of Agriculture

TABLE OF CONTENTS

	Page
INTRODUCTION	1
BACKGROUND	2
SURVEILLANCE PLANNING	3
OPERATIONAL SURVEILLANCE	6
RESULTS	7
Surveillance of Aquatic Resources	7
Surveillance of Malheur Lake and Tributaries	11
Accumulation of DDT in the Food Chain of Rattlesnake Creek	12
Possible Contamination of the Silvies River Following an Accidental Loss of DDT	13
Surveillance of DDT Residues in Big Game	14
DDT Residues in Range Cows	15
DDT Residues in Selected Forage Species	17
Fate of DDT in Forest Floor, Litterfall, Soil and Water	19
Field Volatility of DDT	19
DISCUSSION AND CONCLUSIONS	20

INTRODUCTION

Periodic insect eruptions on forest land must be controlled to prevent disastrous losses of merchantable timber and growing stock. Many forest insect problems are extensive, often endangering trees on thousands of acres.

In the western states, public ownership of forest land is large, and almost any potential danger to forests involves Federal ownerships or lands managed by State or Local governmental units having joint protection responsibilities with Federal agencies. For these reasons, Federal land management agencies are often required to stop harmful buildups of insect pests by aerially applying chemical toxicants. Although intensive research is underway on many fronts to develop better methods, effective control of many forest insects today depends almost exclusively on chemical insecticides.

There is little question that insect control with pesticides is one of the more controversial responsibilities of public agencies. Proposals for insecticide applications by the United States Forest Service have consistently met with resistance from citizens who are concerned about effects on non-target fish, birds, and mammals; their food supplies; and ultimately man himself. Disagreements arising from the use of the chlorinated hydrocarbon pesticides, especially DDT, in many areas of the country have been particularly bitter.

The year 1965 marked a milestone in the history of National Forest aerial spray projects when programs to control infestations of the Douglas-fir tussock moth were conducted in California, Idaho, and Oregon. The Douglas-fir tussock moth is one of the most destructive defoliators of true firs and Douglas-fir in western North America. Surveys have shown that infested stands often survive one defoliation but additional attacks usually cause widespread tree mortality. Prompt control was needed in Oregon because a good share of the affected timber had been defoliated once and some areas twice (Figure 1).

Although tussock moth outbreaks are usually controlled rather quickly by parasites and a virus disease, natural control does not occur until the late stages of larval development. By then most larval feeding has ended and damage has occurred. In the Burns, Oregon area, entomologists predicted that natural control would occur too slowly to prevent widespread tree mortality. Therefore, the decision was made to use DDT, at the rate of 3/4 pound in one gallon of fuel oil per acre, to control the insect. DDT was, and still remains, the only known effective insecticide for control of the Douglas-fir tussock moth.

On the Burns Project in Oregon, DDT was applied exclusively by helicopter. This was the largest, all-helicopter aerial insect spray project ever conducted by the U. S. Forest Service. It was expected that the relatively small acreages and irregular shapes of planned treatment areas would minimize opportunities for birds and mammals to have continuous contact with DDT over extended periods. Also, the use of helicopters would limit application of insecticide only to areas specifically requiring treatment. Stream courses, livestock watering places, meadows, and other nonforested sites could be more easily avoided than with fixed-wing aircraft.

In addition to these safeguards, the Forest Service proposed a surveillance program to detect and evaluate possible side effects on fish and wildlife, range forage, cattle, soil and water. At the request of the Federal Committee on Pest Control, special emphasis was given to surveillance of cattle and range resources, since ranching is a primary industry in the Burns area. This was the first detailed study of possible adverse effects on cattle and range resources on a Forest Service spray project.



**Figure 1.—Young stand
defoliated by
tussock moth
larvae**

BACKGROUND

Tussock moths were first detected in the Burns area in 1963 when 15 acres of defoliated trees were located. By 1964 the infested area had grown to more than 41,000 acres of true fir and Douglas-fir with a good chance of spreading to more than 50,000 acres. The epidemic occurred at five different locations, including Antelope Mountain, Gold Hill, King Mountain, and Vance Creek on the Malheur National Forest and Silver Springs on the adjacent Ochoco National Forest (Figure 2).

Entomologists predicted that the infestation might cover 200,000 acres if not controlled in 1965. By evaluating the incidence of tussock moth virus and determining the proportions of dead larva, they determined that virus infection would not stop the build-up before serious damage was done.

Critical losses to the local economy could have occurred if insects were not controlled and timber losses averted. Most mills in the area depend on National Forest timber. Their combined milling capacity is greater than the available timber so that any loss of timber would have been serious.

Tussock moths had killed 2.6 million board feet of mature timber and immature timber on 1,950 acres with a combined value of \$219,000 by the fall of 1964.

It was estimated that 33,700 acres of young trees and 262.5 million board feet of mature timber would

be threatened by 1965. This potential loss was estimated to be \$4.5 million.

Ultimate losses, unless control was achieved, were projected to 122,000 acres of immature timber and 950 million board feet of mature timber with a value of \$16.5 million. Moreover, the loss in manufactured value and payrolls would be much greater.

The proposed Forest Service control project, using DDT, was approved by the Federal Committee on Pest Control in March 1965. This Committee must approve all Federally financed aerial spray control projects in the United States.

The Northwest Forest Pest Action Council also approved the proposed project. Additional endorsements were obtained from the Pacific Northwest Region Forest Advisory Council, the Malheur National Forest Advisory Council, the Malheur National Forest Grazing Advisory Board, the County Courts of Harney and Grant Counties, and the Harney County Chamber of Commerce.

Spraying began on June 10, 1965, and was completed on July 1. Insect mortality evaluations in each spray area 10 days after spraying indicated that insect kill exceeded 98 percent. Further inspections in the fall of 1965 showed that a virus infection, as predicted, had completely eliminated remaining tussock moths.

SURVEILLANCE PLANNING

The control area included 66,000 acres in five separate units ranging in size from 600 to 23,000 acres (Figure 2). These sites were typical of mountainous central Oregon where most timbered lands are located above 4,000 feet in elevation. They provide summer range for deer and elk but are snow-covered in winter. Livestock also are permitted to graze on timbered lands and the many interspersed meadows in summer.

Fishery resources of the control areas are minimal. Water is scarce and most streams are intermittent or tributaries of inland drainages. Only one stream, Vance Creek, located adjacent to the smallest control unit, drains to the ocean and supports a small run of anadromous fish (Figure 2). Of greater importance in terms of possible hazards was an artificial spawning channel for coho salmon, which drew water from this stream system a short distance below the spray area.

The vast Malheur Wildlife Refuge is located about 25 miles south of the southern most control unit but was believed to be in little danger of contamination from the forest spraying — not only because of the distance, but also because the only waterway from the nearest spray unit seldom carries enough water to reach the Refuge (Figure 3).

Surveillance planning began in the fall of 1964 after agreement among public and private timber managers, livestock associations, sportsmen, civic and conservation organizations that control was necessary if it could be achieved without jeopardizing the well-being of non-target biota.

A preliminary surveillance meeting was organized in November 1964 to assemble interested groups and discuss surveillance needs. Invitations to attend and participate were extended to all agencies, organizations, and individuals who might be interested. Those attending represented a broad cross-section of management and research branches of private, State and Federal agencies. Forest Service personnel described the proposed spray project and led a discussion of potential hazards. It was agreed by all that a surveillance program should be an integral part of the project.

The surveillance effort was formally organized in January 1965 at a meeting to form a working committee of representatives of agencies planning field

surveillance. This committee reviewed, discussed and coordinated planning among agencies to insure that environmental factors of major value or interest would be studied and that efforts would be complementary and not overlap.

The committee agreed that the surveillance program should be conducted by State and Federal agencies responsible for management, protection and investigation of resources which might be adversely affected by the control chemical. Participation was voluntary with the contribution of each agency dependent upon its financial and technical capabilities. Agencies financed and staffed their studies and the Forest Service provided a surveillance coordinator to assist with planning and to coordinate field work.

A final prespray planning meeting was held in March 1965 after approval of the project by the Federal Committee on Pest Control. Agencies represented were those conducting field surveillance. Final plans were completed and problems encountered by individual participants were resolved. Agencies participating in the program and their representatives included:

State of Oregon

Game Commission

Game Division

Melvin S. Cummings, Portland

Miles O. Langdon, Burns

Ralph R. Denny, John Day

Fish Division

Robert L. Borovicka, Portland

Lawrence E. Bisbee, Burns

James A. Hewkin, John Day

Oregon State University

Department of Agricultural Chemistry

Logan A. Norris, Corvallis

Jack B. Vernetti, Corvallis

Department of Fisheries and Wildlife

Gerald E. Davis, Corvallis

Robert W. Brocksen, Corvallis

John D. McIntyre, Corvallis

U. S. Department of Interior

Fish and Wildlife Service

Bureau of Sport Fisheries and Wildlife

Fishery Management Services

W. M. Morton, Portland

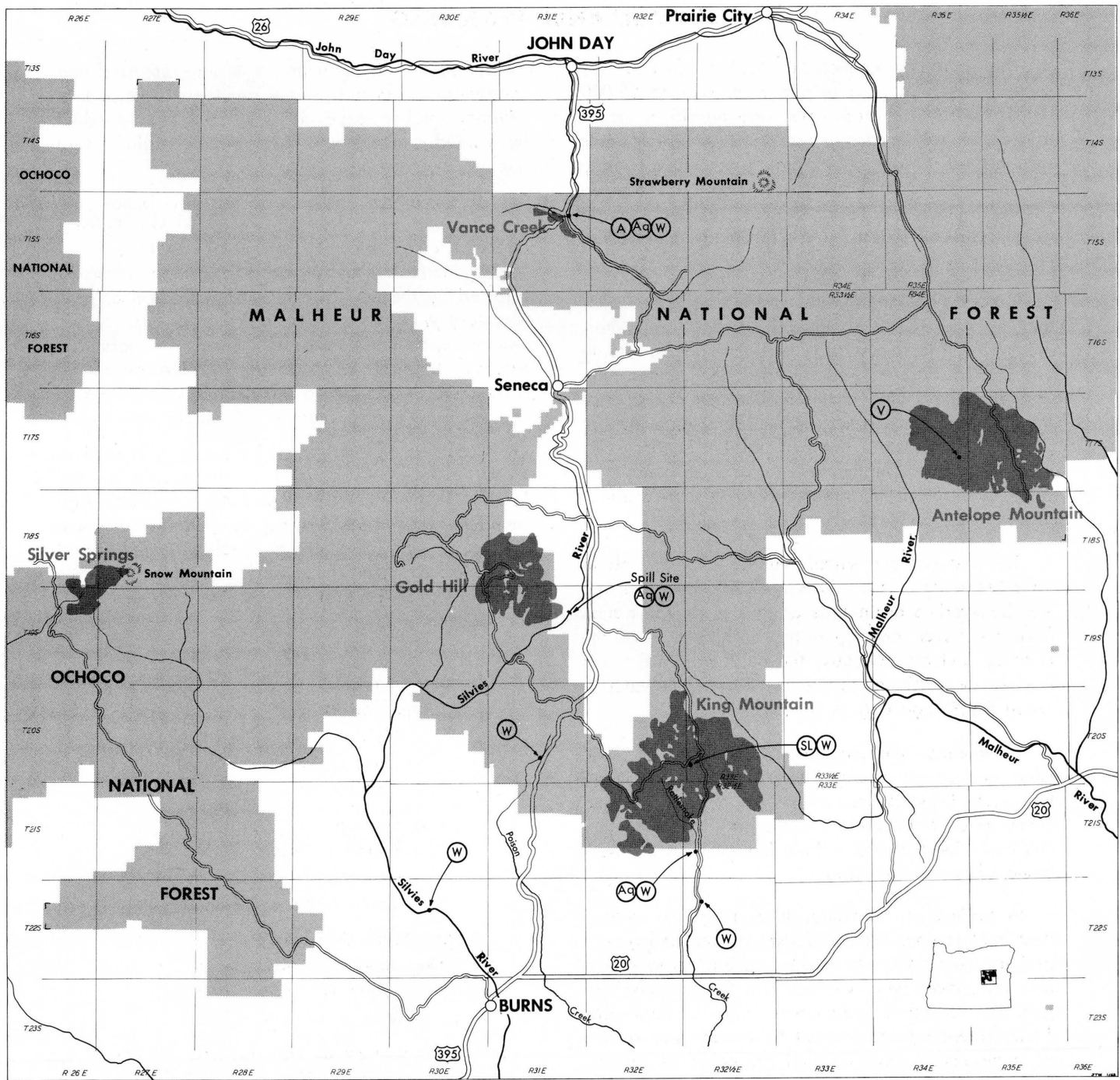
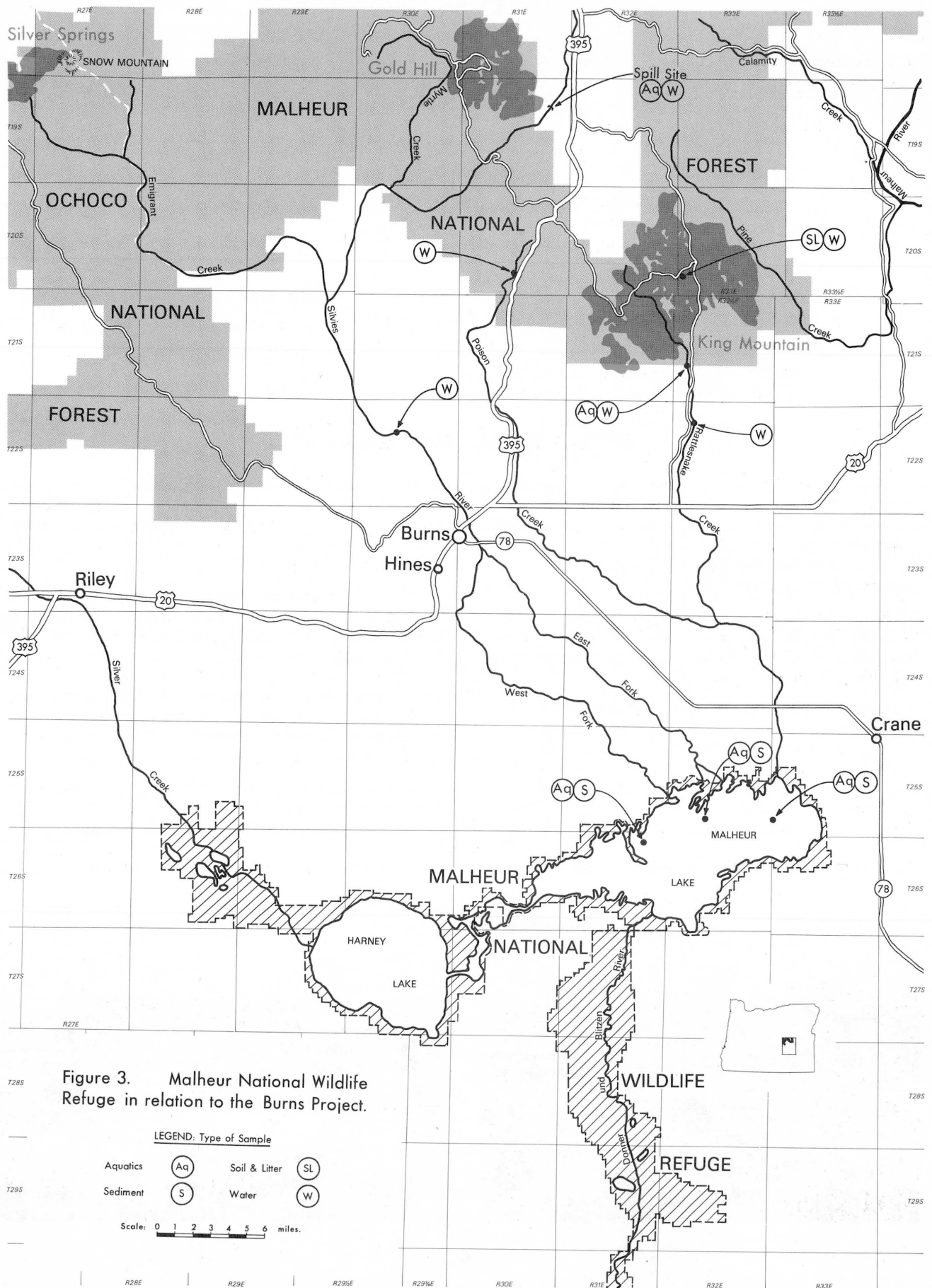


Figure 2. Burns Project spray areas and sampling sites.

Type of Sample		LEGEND:	
Air	(A)	Antelope Mt.	23,000
Aquatics	(Aq)	Gold Hill	11,655
Sediment	(S)	King Mt.	27,334
Soil & Litter	(SL)	Silver Spr.	3,295
Vegetation	(V)	Vance Cr.	661
Water	(W)	Total	65,945

Scale: 0 1 2 3 4 5 6 miles.



U. S. Department of Agriculture

Agricultural Research Service

Entomology Research Division

Pesticide Chemicals Research
Branch

Lillian I. Butler, Yakima,
Washington

Harold W. Rusk, Yakima,
Washington

Forest Service

Pacific Northwest Forest and Range Experiment
Station

Watershed Management, Recreation,
Range Management, and Wildlife

Habitat Research

Gerald S. Strickler, La Grande

Robert F. Tarrant, Corvallis

Pacific Northwest Region

Division of Range and Wildlife
Management

Charles B. Waldron, Portland

Glenn L. Crouch, Portland

Division of Timber Management

Randall F. Perkins, Portland

Malheur National Forest

Herbert B. Rudolph, John Day

OPERATIONAL SURVEILLANCE

Spraying was begun on June 10 and continued intermittently through July 1, 1965. Operations were not continuous because cold, rainy weather delayed insect hatch and disrupted spraying schedules. Surveillance activities tied directly to spraying also were necessarily intermittent.

Spray blocks were released for treatment daily through most of this period which complicated the tasks of surveillance workers committed to sampling just before and during spraying.

Day to day operational planning was similar, even though no spray flights were made on some days. Briefings were held each evening to finalize the next day's work. During each session, areas to be treated were described and individual sections were assigned to sprayer and observer helicopter pilots. When appropriate, the surveillance coordinator indicated

stream courses, meadows and other areas to be avoided and marked their locations on operational maps and aerial photographs. Pilots were frequently cautioned to remain at least one-half swath width (40 ft.) from stream banks.

Following each briefing session, the coordinator contacted those biologists making daily observations of spraying and informed them of areas to be treated the following day. The coordinator also worked closely with the project entomologist to determine when given areas would be sprayed so that nonresident surveillance cooperators could be alerted as far in advance as possible, when their study areas were scheduled for spraying.

Other routine operational surveillance included frequent aerial and ground inspections of spray applications by the coordinator and cooperators. Heli-

Figure 4.—Insecticide loss on road in Silvies Valley



Figure 5.—Feed lot below spill site



port loading sites were periodically inspected to assure that they were located away from water sources. Most heliports were placed on roads, scab-flats, and when necessary, at the edges of meadows. The coordinator also assisted cooperators with periodic sample collections and transported samples to storage facilities.

Only one incident occurred during the project which could have caused serious biological consequences. On the afternoon of June 23, 1965, an estimated 800 gallons of insecticide were lost from a tank trailer when a seam was ruptured as the ve-

hicle crossed railroad tracks in the Silvies Valley (Figure 2). Observations made later the same afternoon indicated that the insecticide drained onto the gravel roadbed. At one location, where the vehicle was stopped, the liquid flowed from the road into a small unoccupied feedlot where most of it was absorbed in the surface soil (Figures 4 and 5). Heavy rains shortly afterward washed part of the solution through the feedlot and into a small irrigation ditch which in turn flowed into a larger channel, and finally into the Silvies River about one mile below the feedlot. Effects of the insecticide loss are discussed later in this report.

RESULTS

Surveillance was conducted by all cooperators that planned studies and, in most instances, the work was carried out as planned. The following reports of the individual cooperators were compiled and edited by the surveillance coordinator. The editor made every effort to maintain the integrity of each report. The authors have concurred.

In addition to formal studies, field observations of spraying were made periodically by the coordinator, Game Commission, and Bureau of Sport Fisheries and Wildlife Biologists. Game Commission observers were usually in the field whenever fish-bearing streams were within spray blocks. Except for a few isolated instances, the observers reported that no DDT was applied to restricted areas.

The Agricultural Research Service, Entomology Research Division, Yakima, Washington, provided information pertaining to sample collections, and conducted chemical analyses for DDT residue in aquatic and big game samples collected by the Game Commission, and fat samples from cows and forage plants obtained by the Forest Service (Figure 6). Liaison was maintained with the Laboratory through Miss Lillian I. Butler.

Malheur National Forest personnel assisted Game Commission biologists with collections of big game fat samples. The Forest Service also arranged for storage and transportation of cooperator samples to the Yakima Laboratory.

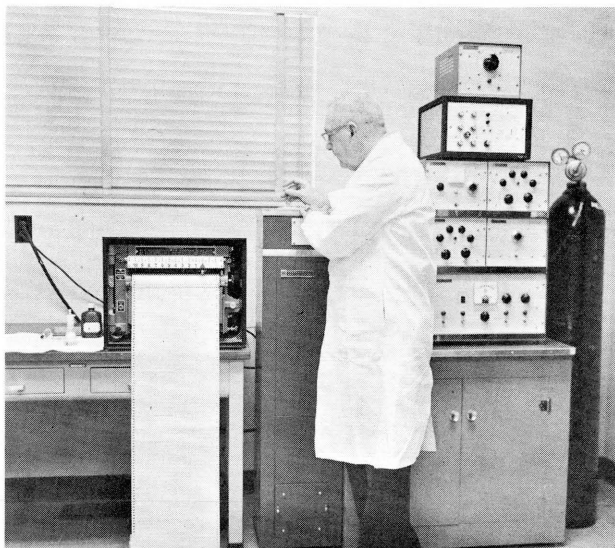


Figure 6.—Gas chromatograph in operation at ARS Laboratory, Yakima

SURVEILLANCE OF AQUATIC RESOURCES

W. Mark Morton, Bureau of Sport Fisheries & Wildlife

James A. Hewkin, Oregon State Game Commission

There are no major water or fishing areas within the control units. Lakes or ponds are virtually nonexistent. Although most streams are small and in-

termittent, some contribute substantial run-off to downstream drainage systems that provide fair to good trout fishing.

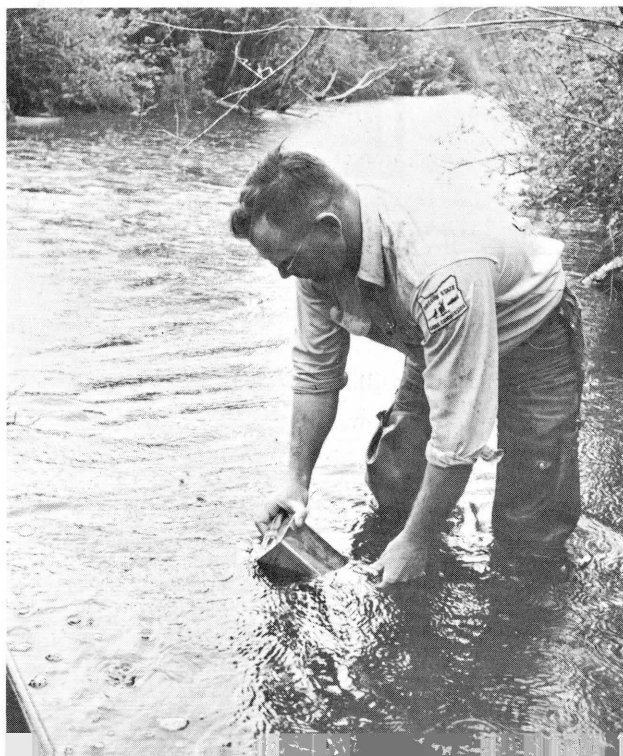


Figure 7.—Aerial view of Malheur Lake

Vance Creek is the only stream in the five control units that drains northward into the John Day River system (Figure 2). Vance Creek, although one of the smallest (about 3.5 miles long and with a summer flow of 2.5 cfs.), presented the most likely potential fishery problem area. As a tributary of Canyon Creek, a major contributor to the John Day River, the lower mile of Vance Creek provides spawning areas for about 50 steelhead trout during April and May. The upper reaches are inhabited by cut-throat and rainbow trout.

Water was diverted from Canyon Creek, about one mile below the mouth of Vance Creek, to supply an artificial incubation channel in which 350,000 coho salmon eggs were planted in the fall of 1964 as part of a cooperative program of the Oregon Game Commission, Oregon Fish Commission, and the Bureau of Commercial Fisheries. These agencies were obviously concerned about possible immediate or long-

Figure 8.—Water sampling at Vance Creek Unit



term effects of the spray application on fish hatched from the planted eggs.

The Silvies River drains all of the Gold Hill unit, most of the Silver Springs unit, and most of the western portion of the King Mountain unit (Figure 2). The southern slopes of King Mountain are drained by a complex of Rattlesnake, Poison, Cow, and other small creeks. All of these waters merge in a huge sump area and in wet years flow into Malheur Lake (Figure 7). The Silvies River supports a sporadic seasonal fishery for trout and warm water species. Other streams are small and support fair to moderate trout fisheries.

Bluebucket and Cottonwood Creeks and tributaries of the Middle and North Forks of the Malheur River, are the most important trout-fishing waters near the Antelope Mountain Unit (Figure 2). The Middle Fork, above the spray area is fished heavily with good success.

Because Vance Creek is a relatively important fishery resource, the Oregon State Game Commission carried out intensive surveillance there, before, during, and after spraying.

Water samples were obtained at the following locations (Figure 8):

1. Canyon Creek — 2 miles above Vance Creek (Control)
2. Canyon Creek — about one mile below Vance Creek, at the Salmon incubation channel
3. Vance Creek — above the mouth.

Table 1.—DDT residues in water — Vance Creek unit.

Location	Sampling period	DDT, parts per billion ¹
Canyon Creek, 2 mi. above Vance Creek (Control area)	Prespray	ND ²
	During spraying	0.4
	2 hrs. postspray	0.3
	4 hrs. postspray	ND
	6 hrs. postspray	ND
	One week postspray	<0.3 ³
	Two weeks postspray	<0.3
Canyon Creek at intake of incubation channel	Prespray	<0.2
	During spraying	0.9
	2 hrs. postspray	<0.3
	4 hrs. postspray	<0.3
	6 hrs. postspray	<0.3
	One week postspray	<0.1
	Two weeks postspray	ND
Mouth of Vance Creek	Prespray	<0.3
	During spraying	4.3
	2 hrs. postspray	0.6
	4 hrs. postspray	<0.3
	6 hrs. postspray	<0.3
	One week postspray	<0.3
	Two weeks postspray	ND

¹ Values not corrected for average percent recovery.

² None detected.

³ (<) — Values are less than the lower limit of instrument sensitivity on the day analysis was conducted.

Table 2.—Aquatic invertebrate counts—Vance Creek Unit

Location	Number counted	
	(Total of 5 samples) Prespray	1 week postspray
Canyon Creek	617	604
Vance Creek	150	119

Table 3.—DDT in aquatic invertebrates—Vance Creek Unit

Sampling time	Residues in Parts per million ¹				Combined DDT and metabolites
	DDE	o,p'-DDT	TDE	p,p'-DDT	
Prespray	0.08	ND ²	ND	ND	0.08
One week postspray	0.26	0.11	ND	0.55	0.92

¹ Results have not been corrected for control values nor for average percent recovery.

² None detected.

Samples were collected in new gallon cans which had been previously rinsed with acetone. The cans of water were kept frozen until analyzed for DDT content.

Prespray samples contained no detectable DDT at any location (Table 1). Low levels of DDT were detected in water collected during spraying at all locations, even the "control" area. No residues were detected 2 hours later except in Vance Creek, and none were found in samples collected during the succeeding two-week period.

Aquatic invertebrates were counted at 5 locations in Canyon Creek, and 5 in Vance Creek. Sampling was accomplished by using the boot heel to disturb the stream bottom in a foot-square area and collecting the drift material on a fine mesh screen. Aquatic invertebrates were more abundant in Canyon Creek than in Vance Creek before and after spraying (Table 2). Results of chemical analyses of pre and postspray samples of aquatic invertebrates are shown in Table 3.

Table 4.—Trout obtained by electrofishing—Vance Creek Unit

Feet of stream fished	Sampling period	
	Prespray	One week postspray
50	8	11
120	23	29

Fish collected by electro-fishing were measured and released in Vance Creek (Figure 9 and Table 4). In addition, a one-pound sample of trout was obtained for analysis. Although no dead fish were observed, a sample of coho fingerlings from the Canyon Creek incubation channel was also collected for chemical analysis. Unfortunately, this sample was misplaced and never reached the Yakima Laboratory.

**Figure 9.—Electro-fishing in Vance Creek**

Native trout collected by electro-fishing were placed in live-boxes at three locations, (1) Canyon Creek, outside the spray area, (2) Canyon Creek, below the spray area, and (3) Vance Creek, near its mouth (Figure 10).

No ill effects from the spray treatment were noted in any specimens during the three weeks following spraying. At that time, all live-box fish were sacrificed for residue analyses (Table 5).

Three fyke nets were placed in Vance Creek to collect drifting fish and invertebrates during and after spraying. One net was installed near the upper spray area boundary, a second about midway, and the third was placed near the mouth of the creek. During spraying and for almost a week afterward, nothing was caught in the nets. Heavy rains drenched



Figure 10.—Live fish from Vance Creek

Table 5.—DDT in trout — Vance Creek Unit

Sampling period	Residues in parts per million ¹				
	DDE	o,p'-DDT	TDE	p,p'-DDT	Combined DDT and metabolites
Prespray	0.12	ND ²	0.01	0.06	0.19
One week postspray	0.10	0.04	0.03	0.33	0.50
Four weeks postspray	0.13	<0.02	0.01	0.17	0.31

¹ Residues have not been corrected for control values nor for average percent recovery.

² None detected.

the area seven days after spraying and may have contributed to the fish and insect mortalities thereafter, especially in the upper fyke nets (Table 6 and Figure 11).

The nine dead rainbow trout taken from the upper net on June 17 ranged from two to four inches in length, and the five live fish from four to six inches. The insect drift from the upper net consisted of two large stonefly nymphs. Two caddis larvae were dead and the remaining caddis larvae were moving about and attempting to leave their cases. Live stonefly nymphs were taken only in the middle and lower nets. No dead invertebrates were found in Vance Creek except at the upper fyke net. The dead fish and a sample of the dead insects were analyzed for DDT residues. Results of the analysis are shown as postspray values in Tables 5 and 3 respectively.

Strange as it may seem, we know of no bonafide example of a significant trout kill that can be traced directly to the immediate effects of DDT in any western water in the last decade. An exam-

ination of the literature on this subject indicated that adult trout are rather hard to kill with DDT (at the usual forest application rates) in cold, well-oxygenated, running water. On the other hand, there is a wealth of published information which shows that DDT has disastrous effects on aquatic insects.

In the Burns Project, no really significant fishable bodies of water were located within the treated areas except Vance Creek. The only **known** fish mortality that could possibly have been associated with actual spraying occurred in Vance Creek. Surveillance indicated that losses there were small. Losses of aquatic invertebrates were observed only where headwaters of streams such as Vance Creek were sprayed.

Finally, no permanent damage to the aquatic environment has been observed or recorded.



Figure 11.—Fyke net in Vance Creek

Table 6.—Postspray drift samples from 3 locations on Vance Creek — 1965

Date	Upper			Middle			Lower			Totals		
	Fish		Insects	Fish		Insects	Fish		Insects	Fish		Insects
	Live	Dead		Live	Dead		Live	Dead		Live	Dead	
June 17	5	9	12	1	0	2	10	1	2	16	10	16
June 18	4	16	3	1	1	0	0	0	0	5	17	3
June 19	6	0	0	0	0	0	4	0	0	10	0	0
June 21	8	7	0	0	0	0	2	0	0	10	7	0
	23	32	15	2	1	2	16	1	2	41	34	19

SURVEILLANCE OF MALHEUR LAKE AND TRIBUTARIES

W. Mark Morton

Bureau of Sport Fisheries and Wildlife

Although none of the southern control units of the Burns Project contained important fishing waters, the Bureau of Sport Fisheries and Wildlife was particularly interested in two of them. Over half of the acreage treated was included in the King Mountain and Gold Hill Units. Nearly all of the run-off from these areas eventually empties into Malheur Lake, 25 miles to the south, through the Silvies River and adjacent intermittent streams (Figure 3). The Bureau was especially concerned about possible effects of this run-off on its largest waterfowl refuge in the West, the Malheur National Migratory Waterfowl Refuge in Harney County, Oregon.

In ordinary dry years, these waters are completely absorbed by the 50 square mile former marsh east of Burns and north of Malheur Lake. Most of the excess run-off from the Silvies River is spread out through a maze of canals over pasture lands and hay meadows so that water from the Silvies reaches Malheur Lake only in very wet years, which are relatively uncommon in southeast Oregon.

When the project was first proposed, it seemed doubtful that DDT applied 25 miles away would affect refuge waters. But, because (1) an unusually heavy runoff might cause Silvies River water to reach the refuge, (2) part of the Silvies watershed had been treated with DDT in 1958, and (3) dieldrin had been applied on refuge lands bordering Malheur Lake for grasshopper control, it was deemed advisable to establish "benchmark" tests of waters and resident aquatic organisms in the Lake to determine the present level, if any, of contamination from these chemicals. This information would provide a basis for evaluating any adverse effects that might be associated with future pesticide applications in the watershed.

To establish base levels of residues, the refuge wildlife biologist collected water samples from Rattlesnake and Poison Creeks, and the Silvies River (Figure

3). Samples were obtained in April, May, June, August, and October 1965.

One gallon of water was taken from each location and combined into one sample which was then filtered to remove all suspended material. The filter papers were then placed in plastic bags and frozen. Results of residue analyses by Stoner Laboratories, Inc., Campbell, California, are shown in Table 7.

Table 7.—DDT in tributary waters of Malheur Lake

	Collection date	Sample composited from	DDT, parts per billion
Prespray	April 5	Rattlesnake and Poison Creeks, Silvies River	2.6
	May 5	Rattlesnake and Poison Creeks, Silvies River	0.5
	June 17	Rattlesnake and Poison Creeks, Silvies River	0.2
Postspray	August 6	Rattlesnake and Poison Creeks, Silvies River	0.2
	October 12	Rattlesnake and Poison Creeks	0.1

Three sampling stations were established in Malheur Lake to collect sediment, fish, vegetation and plankton samples. Sediment collection bottles were anchored in March and samples collected on the same dates as water sampling. Sediments from each station were composited and air dried in a cool, dark room. One quart of dried material was then frozen. Fish, vegetation, and plankton samples were collected in May and August. Results of DDT analyses by the Stoner Laboratory are shown in Table 8.

Table 8.—DDT in aquatic substrates from Malheur Lake — 1965

Substrate	No. of analyses ¹	Means and ranges of DDT and metabolites, parts per million
Sediments	4	0.50 (0.05-1.21)
Pondweeds	8	0.17 (0.02-0.52)
Invertebrates	5	0.03 (0.01-0.04)
Fish	4	0.08 (0.04-0.16)

¹ Several samples collected at various dates at different stations were composited for each analysis.

Results indicated that DDT applied during the Burns Project had little effect on the waters and organisms of Malheur Lake. Water samples from the upper tributaries of the Silvies River contained only small amounts of DDT before and after spraying. In fact, residue levels in prespray samples were considerably higher than in those obtained after treatment.

Although high run-off in the Silvies River in May and June 1965 raised the level of Malheur Lake considerably, none of the stream flow reached the lake after mid-July. Therefore, no contaminated water, if indeed such ever existed, could have reached the lake after the spray project was completed.

ACCUMULATION OF DDT IN THE FOOD CHAIN OF RATTLESNAKE CREEK

Robert W. Brocksen, John D. McIntyre and Gerald E. Davis

Department of Fisheries and Wildlife

Oregon State University

Studies of pesticide accumulations in the food chains of simplified laboratory stream communities have been carried on for the past several years by the Department of Fisheries and Wildlife, Oregon State University. The 1965 Burns Project for control of the Douglas-fir tussock moth in the Ochoco and Malheur National Forests provided an opportunity to study the accumulation of DDT in a more complex natural stream community. A small stream, Rattlesnake Creek, located approximately 16 miles north-east of Burns, Oregon, in the King Mountain control Unit of the Malheur National Forest was chosen for the study (Figure 2). The stream is readily accessible by road and usually has a perennial flow.

The objective of the study was to determine levels of DDT in the water and in different organisms of the stream community under the conditions of a carefully controlled forest-insect spray program.

Samples of water and organisms were collected at two sites on the stream: one site was a short distance downstream from the spray area; the other approximately one-half mile further downstream, below the boundary of the Malheur National Forest. Prespray samples of water, plants and animals were collected in May 1965. Postspray sampling was conducted in July and October, 1965, and in February and May, 1966. Water was collected in one-gallon metal cans and frozen until analyzed. Plant sampling was mainly confined to the filamentous algae that could be gathered from rubble in the stream. Collections of insects and other invertebrate animals were made by disturbing the stream bottom immediately upstream from a fine-mesh net into which the animals were carried by the water current. Rainbow trout and dace were captured by seining the stream or with the use of an electrical fish shocker. No effort was made to obtain quantitative samples of the stream fauna as it was beyond the scope of the study to determine changes in the abundance of the animals resulting from the pesticide application.

The invertebrates collected in the samples were grouped, usually according to family. Each group was first wrapped in aluminum foil then placed in plastic bags and frozen with dry ice. Plant and fish samples were treated similarly. All samples were kept frozen until analyzed. Analyses were performed by the Department of Agricultural Chemistry, Oregon State University, by means of electron-capture gas chromatography. Because of the small size of some samples, it was not always possible to confirm the identity of the pesticide residues by an independent method. Thus, it is possible that some naturally occurring compound was identified as DDT or one of its metabolites.

The results are given as average concentrations of DDT residues found in different components of the stream during different seasonal periods (Table 9). Values shown for insects are based on those forms that were present in samples on most or all of the sampling dates. Species of herbivorous insects included stoneflies, caddisflies, mayflies, and black flies. Among the carnivorous insects were stoneflies, caddisflies, damselflies, dragon flies, and beetles. The dace and trout are primarily insectivorous.

Values shown for the May 1965 sample indicate that small concentrations of pesticide were present in the stream system before the control program was begun. The concentrations of DDT in all water samples were very low, being near the limits of sensitivity of the analytical method. Pesticide residues in the algae were highest in samples collected in October 1965, whereas the residues in animals were generally highest in the sample taken in July 1965, shortly after spray application. There was a decline in pesticide concentration in samples of animals between July 1965 and February 1966. The May 1966 sample showed that residues in dace were as high as those found in the first postspray sample. Between February and May 1966 residues in trout increased but not as markedly as in the dace.

Pesticide concentrations generally increased through the different food levels of the stream from the water through the plants, insects, and fish. Fish in all samples accumulated more residue than carnivorous insects. On two sampling dates, July 1965 and February 1966, greater concentrations were found in herbivorous insects than in carnivorous insects. Accumulations of residues were always greater in herbivorous insects than in algae. The July and October 1965 samples showed some increase in concentration of DDT in algae compared with water. Samples taken in February and May 1966, however, showed no great differences in DDT residues between algae and water.

Levels of DDT accumulation were very low in all components of the community that were sampled. The highest observed concentration was approximately 1.2 parts per million in trout collected shortly after spraying. The reduction of pesticide concentrations from July to October suggests that rainfall in the area during August did not cause movement of the chemical into the stream. However, increases in residues in trout and dace between February and May

1966 do suggest that additional quantities of DDT may have reached the stream during this period, perhaps as a result of run-off from melting snow.

Sampling was too infrequent and amounts of material collected were too small to provide reliable data for accurate measurement of the movement of the pesticide through the stream community. However, results are probably sufficiently reliable for concluding that the DDT application did not result in any great accumulation of the chemical in the different food levels of the community.

Table 9.—DDT and metabolites in the Rattlesnake Creek community, ppm, wet weight

Component	Sampling Dates				
	1965			1966	
	May	July	Oct.	Feb.	May
Prespray					
Water	0.010	0.010	0.010	0.010	0.015
Algae	0.019	0.042	0.087	0.010	0.010
Herbivorous insects	0.080	0.770	0.145	0.220	0.098
Carnivorous insects	0.053	0.320	0.203	0.160	0.140
Dace	0.076	1.015	0.440	0.180	1.060
Trout	0.340	1.197	0.570	0.265	0.487

POSSIBLE CONTAMINATION OF THE SILVIES RIVER FOLLOWING AN ACCIDENTAL LOSS OF DDT

W. Mark Morton
Bureau of Sport Fisheries and Wildlife
Glenn L. Crouch
U. S. Forest Service

Intensive examinations of the area of DDT loss were begun early on June 24, 1965, about 14 hours after the accident, by Bureau of Sport Fisheries, Game Commission and Forest Service personnel. At that time, oil was observed on the small irrigation ditch nearest the spill site, but none was seen downstream below its confluence with a larger ditch. Dead insects were found in the smaller ditch and a sample was collected for analysis. Water samples were also taken periodically from the ditch and from the Silvies River above and below the ditch mouth. Results of analyses for DDT in these samples are shown in Table 10.

Helicopter flights over the slow-flowing Silvies River from the City of Burns upstream to the spill site revealed no dead fish, oil slicks or other evidence of pollution. According to the local Game Commission Fishery Biologist, that part of the river provided fair to poor game fish habitat and contained many trash fish.

The ditches and river were inspected by Forest Service personnel each day until completion of the

Table 10.—DDT in water, insects, and fish — Silvies River and tributary ditches

Component	Location	Sampling date	DDT ¹
(1965)			
			Parts per billion
Water	Ditch (at spill site)	June 24	23.0
	Silvies R. above ditch mouth	June 24	ND ²
	Silvies R. below ditch mouth	June 24	ND
			Parts per million
Dead insects	Ditch (at spill site)	June 24	101.0
Live fish	Silvies R. 1/2 mile below spill site	June 27	1.58
	5 mi. below spill site	June 27	0.97
	1/2 mi. below spill site	July 1	2.12
	20+ mi. below spill site	July 1	0.14
	6 mi. above spill site	July 26	0.14
	5 mi. below spill site	July 28	0.72

¹ Values have not been corrected for control or average percent recovery.

² None detected.

project on July 1. The local Game Commission Fishery Biologist made further observations periodically and collected samples of live fish from the Silvies River above and below the spill site for about

one more month. Residue levels in these fish are shown in Table 10.

Periodic surveillance of water below the spill site revealed no visible effects of DDT on aquatic organisms after the first day. Analyses of water samples composited from the Silvies below the spill site and Rattlesnake Creek, below the King

Mountain Unit, showed DDT residues below pre-spray levels in October 1965, about 4 months after the loss.

Although planned for longer duration, surveillance of the ditches and Silvies River was ended in late summer after it was determined that no effects of the spillage could be detected.

SURVEILLANCE OF DDT RESIDUES IN BIG GAME

Melvin S. Cummings

Oregon State Game Commission

Both fish and game could have been affected by the Burns tussock moth control project. All of the treated areas are good deer summer range. Populations range from an estimated 35 deer on the Vance Creek Unit to 400 deer each on the King Mountain and Antelope Mountain Units. All units except Vance Creek are also good elk summer range. Estimated elk numbers range from 10 to 15 on the smaller units and from 25 to 30 on the King Mountain Unit. An estimated 1,025 deer and 75 elk are summer residents on the project area (Figure 12).

Small numbers of blue and ruffed grouse are dispersed throughout all areas. Snowshoe hare are found on the timbered lands.

By the time the State Game Commission was notified of the proposed control project there was insufficient time to obtain valid pretreatment data regarding numbers, weights, distribution and reproduction of game birds and animals on these lands. Big game harvest was estimated to be 210 deer and 25 elk per season from the project lands. Consequently, the objective of the Oregon State Game Commission regarding game was to determine levels

of DDT residues in game animals and birds prior to and immediately after spraying, and during the following fall hunting seasons.

To determine DDT residue levels in game animals prior to the spraying, samples of fatty tissue were collected from locker stored deer and elk known to have been killed on the project area during the 1964 hunting season. Forest Service personnel obtained the majority of the 12 deer and 9 elk tissue samples collected. Whole grouse were requested for analysis. However, none were collected during the study.

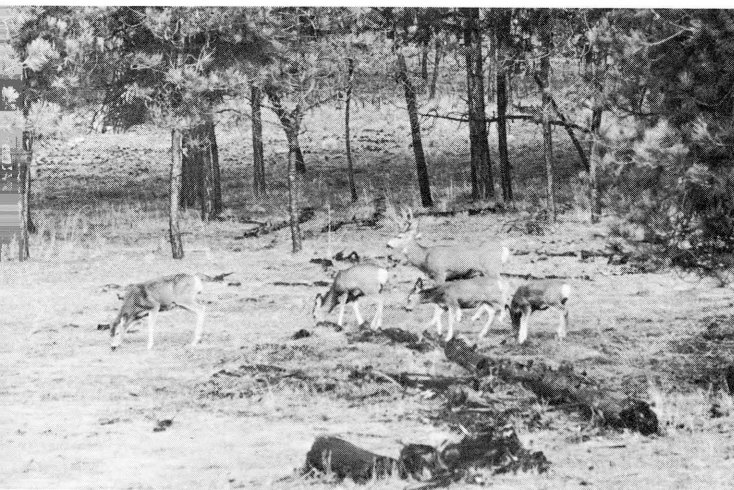


Figure 12.—Mule deer on Malheur National Forest

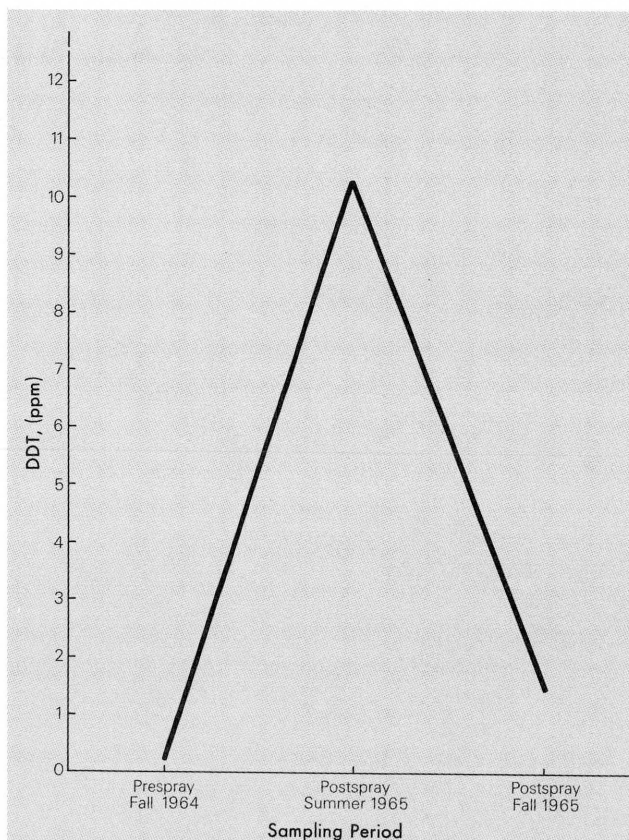


Figure 13.—DDT residues in deer

Six deer were collected by Game Commission biologists 30 to 45 days after spraying on the Silver Springs and King Mountain spray areas. During the 1965 deer and elk seasons, 12 deer tissue samples of 10 to 20 grams were removed from freshly killed animals, placed in containers provided by the Agricultural Research Service, frozen, and shipped by air to Yakima for laboratory analysis.

Both deer and elk samples taken prior to spraying showed DDT levels far below the maximum tolerable level of 7 parts per million established for domestic meats; deer averaged 0.207 ppm. and elk averaged 0.735 ppm. (Table 11).

Deer samples collected 30 to 45 days after spraying varied greatly. Residues in two samples appeared very similar to prespray values. The other four

contained DDT ranging from 7.83 to 31.05 ppm. (Average 15.47 ppm.), well above tolerable levels.

DDT in the 11 deer fat samples taken during the 1965 hunting season varied in content from 0.07 to 5.21 ppm. (Average 1.45 ppm.). This average approximates the 1.83 ppm. of DDT found in the single elk sample.

Results obtained from analysis of fat tissue indicate big game animals in this area are carrying small amounts of DDT at all times. Buildup of residues after spraying are rapid and excessive (Figure 13). However, high levels also appear to dissipate readily and game meat is again acceptable for human consumption 120 days after a DDT spray control program. As was stated initially, no conclusions can be drawn from this project on the biological effects of high levels of DDT residues in game animals.

Table 11.—Averages and ranges of DDT in big game

Sampling period	Animal and number	Residues in parts per million ¹				
		DDE	TDE	o,p'-DDT	p,p'-DDT	Combined DDT and metabolites
Prespray (from 1964 hunter kills)	12 deer	0.048 (0.011-0.078)	0.057 ² (0.01-0.488)	0.028 (0.01-0.085)	0.074 (0.029-0.090)	0.207 (0.011-0.561)
	9 elk	0.223 (0.022-0.836)	0.108 (<0.01-0.489)	0.33 (<0.01-0.203)	0.361 (0.019-1.38)	0.735 (0.088-2.22)
		DDE	TDE+ o,p'-DDT		p,p'-DDT	Combined DDT and metabolites
Postspray (30-45 days after spraying)	6 deer	0.54 (0.02-0.72)	2.52 (0.03-8.24)		7.33 (0.09-21.24)	10.39 (0.14-31.05)
Postspray (from 1965 hunter kills)	11 deer	0.11 (0.01-0.36)	0.35 (0.01-1.58)		0.99 (0.05-3.27)	1.45 (0.07-5.21)
	1 elk	0.82	0.31		0.70	1.83

¹ Values have been calculated to 100 percent recovery and are based on 100 percent crude lipid.

² <Values are less than the lower limit of instrument sensitivity.

DDT RESIDUES IN RANGE COWS

Charles B. Waldron, U. S. Forest Service

Herbert B. Rudolph, U. S. Forest Service

Following the decision to aerially spray for tussock moth control, an analysis was made of the possible impact of the project on cattle permitted to graze within the proposed treatment areas. Results showed that some 4,600 head, owned by 34 permittees, grazed within the areas to be sprayed at least part of the summer.

As suggested by the Agricultural Research Service, and after consultation with experts at Oregon State University, the Pacific Northwest Forest and Range Experiment Station, the Oregon State Department of Agriculture and representatives of the livestock industry, a plan was developed for determining the contribution of the spray project to DDT residue levels in permittee range cattle.

It was evident that random sampling of all permitted cattle would not be feasible, or even possible within financial and manpower limitations of the project.

To obtain cows for sampling, cooperation was solicited from appropriate permittees in order to select one whose allotment was representative of grazing conditions within the treatment areas. Mr. Joseph Altnow of Drewsey, Oregon, agreed to cooperate with the Forest Service by allowing fat samples to be collected from cows which would graze on the Antelope Unit. The formal agreement provided that the cows sampled before spraying would also be sampled in the fall after returning from the summer range. An additional sampling one year after spraying was subsequently added.

Veterinary services and supplies were contracted from A. H. Stevenson, D.V.M., of John Day. Dr. Stevenson collected 4 to 36 grams of body fat surgically from the upper hind quarters of the cows (Figure 14). Mr. Altnow and Forest Service personnel assisted with handling of the stock (Figure 15). Samples were immediately packed in dry ice and kept frozen until analyzed by the Agricultural Research Service Laboratory.

Three groups of samples were obtained. The prespray collection from 11 cows was obtained in early June, 1965, prior to turnout on National Forest range. One postspray collection was made in December, 1965, after the cows had returned to the ranch. Only 5 of the original 11 head were available for this postspray sample. A third sampling was made approximately one year after spraying; some 8 months after the cows left the treated area.

Results of chemical analyses at the Agricultural Research Service Laboratory, Yakima, are shown in Table 12. The legal tolerance limit for DDT in the fat of cattle to be used for domestic meat supplies has been established at 7 ppm. Only one sample, collected in the fall of 1965 exceeded 7 ppm. This one contained 7.72 ppm. As the tabled data show, average residue levels from all sampling periods were below 7 ppm.



Figure 14.—Collecting fat from cow for residue analysis

It is recognized that sample sizes were relatively small and cows were not selected randomly. Nevertheless, the Altnow herd was considered to be representative of cattle that could have been exposed to DDT on the treated areas.

Pre-treatment samples averaged 0.22 ppm. of combined DDT and metabolites. Approximately one year later the average was 0.69 ppm. (Figure 16). Both values are well below the legal tolerance. These values indicate that DDT can be used to protect forests from insect attacks without apparent adverse effects on domestic livestock if the chemical is applied by precision spraying as accomplished in the Burns Project.

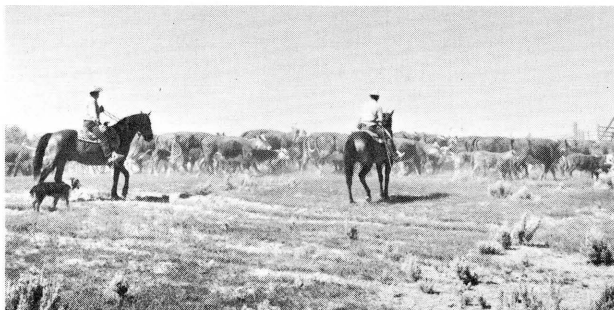


Figure 15.—Gathering cows for sampling

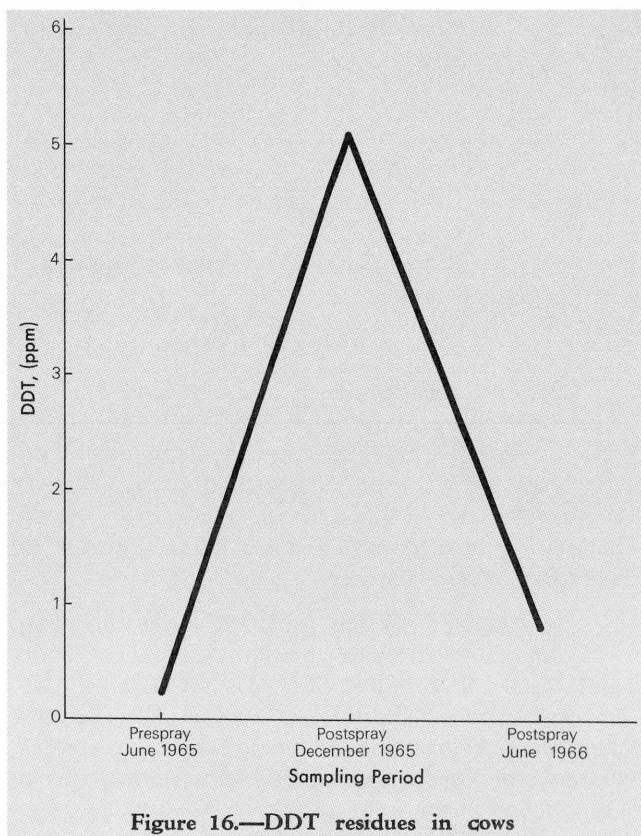


Figure 16.—DDT residues in cows

Table 12.—Average and ranges of DDT in cows

Sampling period	Number of samples	Residues in parts per million ¹				
		DDE	TDE	o,p'-DDT	p,p'-DDT	Combined DDT and metabolites
Prespray June 1965	11	0.022 (<.01-.057)	0.079 (<.01-.227)	<.01	0.115 (<.025-.188)	0.22 (.026-.535)
Postspray December 1965	5	2.16 (.59-3.90)	1.62 (.55-2.56)	0.43 (.21-.93)	0.99 (.32-1.89)	5.20 (1.69-7.72)
		TDE + o,p'-DDT				
Postspray May 1966	6	0.36 (<.02-1.03)	0.04 (<.02-.11)		0.29 (<.04-.82)	0.69 (<.04-1.96)

¹ Values have been calculated to 100 percent recovery and 100 percent crude lipid.

DDT RESIDUES IN SELECTED FORAGE SPECIES

Gerald S. Strickler

Pacific Northwest Forest and Range Experiment Station

Harold W. Rusk

Agricultural Research Service

Much of the land within the treatment areas is grazed by livestock and wildlife. The late spring and early summer DDT application for control of the moth exposed forage species to DDT at the start of the summer grazing season. Therefore, herbage samples were taken to determine the persistence of DDT residues on three important forage species because of the possible role of these species as food chain carriers of DDT residues. To meet this objective, the study was designed to measure amounts of DDT residues on herbage samples at intervals up to 12 months after spraying.

Elk sedge (*Carex geyeri* Boott), tailcup lupine (*Lupinus caudatus* Kell.), and big sagebrush (*Artemisia tridentata* Nutt.) were the forage species se-



Figure 17.—Herbage sampling — plastic gloves were worn to avoid contamination

lected. All sampling was done within the Antelope Mountain Unit on two livestock allotments (Figure 2). Cattle, deer, and a small herd of elk graze these areas summer-long.

Sixteen half-acre plots were established for clipping herbage samples of one or two species. Each plot had sufficient herbage of the species sampled to efficiently obtain one-half to one pound dry weight in composited samples. Although located selectively, the plots were well distributed within the Antelope Mountain Unit. Sampling plots were fenced to prevent possible DDT contamination and herbage reduction by grazing cattle.

Within the sampling plots, 20 subsampling points were randomly located for clipping herbage of elk sedge and lupine (Figure 17). Sagebrush samples were obtained from 21 individual shrubs, the subsample point being the center of the crown of each shrub.

The area around each subsampling point, or shrub center, was divided into four quarters, the bisectors parallel with main plot boundaries. Clipping was confined to one quarter at each point, or shrub, during each sampling period. Before clipping, and to prevent trampling and possible contamination, an estimate was made of the area required in the quarter to obtain the designated grams of each species and clipping proceeded toward the subsample point. Subsample clippings were composited for sample analyses. Samples consisted of current leaf and twig growth of big sagebrush, current growth of tailcup lupine, and because its leaves remain green for a

few years, both current and old green growth of elk sedge.

The composited samples were frozen on the day clipped, and later shipped frozen to the Agricultural Research Service Laboratory in Yakima, Washington. All samples were kept frozen until processed for analysis. Residue analyses were conducted by the Pesticide Chemicals Branch at the laboratory.¹

Samples were clipped during one prespray and three postspray periods.

Prespray	May 26 - June 9, 1965
1st postspray	June 21-27, 1965
2nd postspray	October 10-11, 1965
3rd postspray	June 28-29, 1966

Eleven, seven and five composited herbage samples of elk sedge, lupine, and sagebrush respectively were clipped during each period, except for one elk sedge and one and two lupine samples which were not collected because of insufficient spring growth or unexpected use by cattle.

Just before spraying, 9 oil-sensitive dye cards secured to wire stands approximately 1.5 feet above the ground surface, were equally spaced in a grid pattern within each one-half acre sample plot (Figure 18). Cards were collected after spraying and evaluated for amount of spray (gallons/acre) reaching the card level. All sites were sprayed with amounts ranging from 0.12 to 1.6 gallons/acre.

¹ Details of sampling and analysis procedures will be presented in a subsequent research publication by these authors.

A summary of the residue analyses of the three species are illustrated in Figure 19.

From a high level immediately following spraying, amounts of DDT residues decreased rapidly during the four months following spraying. However, the fourth-month samples, clipped at the close of the livestock grazing period, averaged higher in DDT residues than the prespray samples. Residues in elk sedge and tailcup lupine were about twice the maximum of 7 ppm. presently set for commercial live-



Figure 18.—Spray card for evaluating DDT applied to vegetation plot

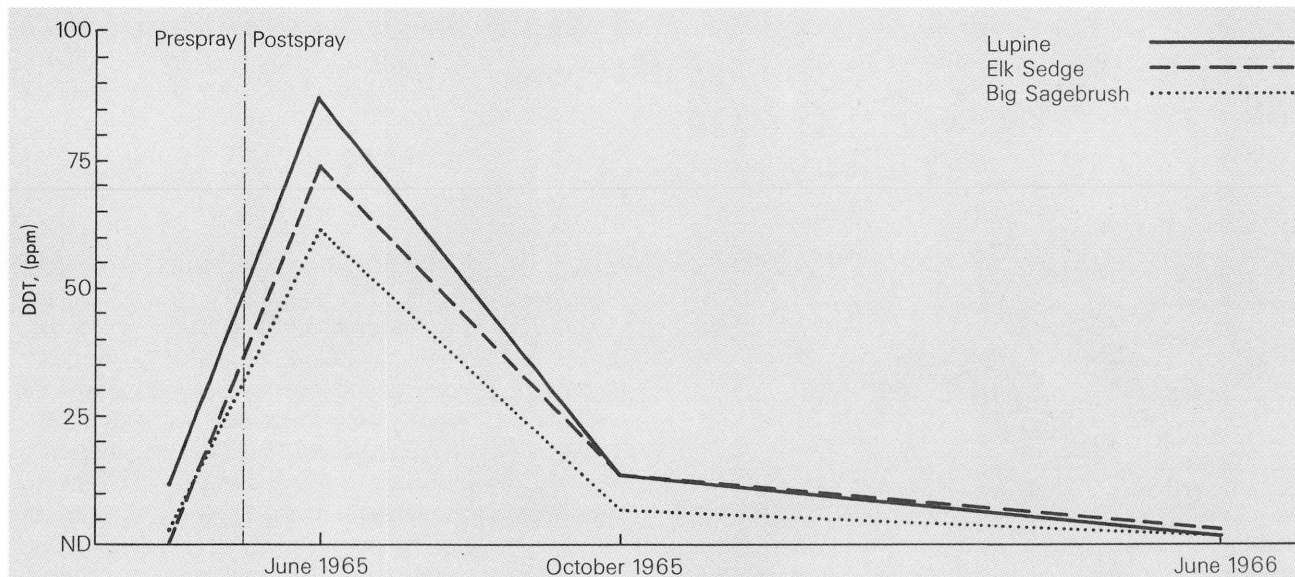


Figure 19.—DDT residue associated with three forage species, before and after spraying

stock hay. Only one sample of big sagebrush (at 13.2 ppm.) contained more than 7 ppm. DDT residue at the close of the grazing period.

DDT residue levels in tailcup lupine and big sagebrush samples clipped one year after spraying were lower than prespray levels whereas residues in elk sedge averaged about four times higher than pre-

spray levels, yet much below 7 ppm. Reasons for these shifts in residue levels in the three species, and particularly for the high prespray levels found in tailcup lupine and big sagebrush, cannot be explained since non-sprayed control samples were not taken during each sampling period. Still the data indicate little if any cycling of DDT residues in the species sampled within one year after spraying.

FATE OF DDT IN FOREST FLOOR, LITTERFALL, SOIL AND WATER

Robert F. Tarrant

Pacific Northwest Forest and Range Experiment Station

In addition to surveillance activities, a long-term research program was initiated by the Pacific Northwest Forest and Range Experiment Station to study several aspects of the effect of aerially applying DDT to a forest area. This study, which is not yet completed, is designed to answer the following questions:

1. How much of the DDT spray solution reaches the forest floor during initial application?
2. What is the distribution pattern of aerial spray beneath the forest canopy?
3. Does DDT move downward from the surface of the forest floor with time?
4. Does DDT affect soil microbial populations and their makeup?
5. Over a number of years after spray was ap-

plied, does DDT continue to be deposited on the forest floor as a result of precipitation washing and natural litterfall?

6. What is the level of DDT in streamwater draining the spray area over a period of years?
7. What is the background level of DDT in soil and streamwater prior to spraying?

As of July 1967, sampling of forest floor, soil, throughfall precipitation, litterfall, and streamwater had been completed for the first 2 years after spraying. Samples have been analysed for amounts of DDT and for characteristics of the soil microbial population. A minimum of 3 years after spraying must elapse before any conclusions can be drawn from this study. Results will be published and made publicly available through normal channels for research findings.

FIELD VOLATILITY OF DDT

Jack B. Vernetti and Logan A. Norris

Dept. of Agricultural Chemistry
Oregon State University

A single air sampling station was operated within the Vance Creek Unit to measure the level of air contamination resulting from the application of DDT during the Burns Douglas-fir tussock moth control program.

About 600 acres were treated with 3/4 lb. per acre of DDT in diesel oil in the Vance Creek Unit during the morning of June 10, 1965. The maximum temperature of June 10 was 92° F.

The sampler was operated June 12 from 9:15 a.m. until 12:15 p.m. when a change in wind direction necessitated moving the sampler to a second location. Winds became erratic and gusty by 3 p.m. with velocities reaching 10-15 miles per hour. Rain began

to fall at 4 p.m. and the sampling device was shut off. Temperatures during the morning sampling period averaged 74 degrees. During the afternoon a high of 83 degrees was reached with a drop to 68 degrees observed by 4 p.m.

Samples were obtained by drawing a large volume of air through a solvent trap with a vacuum pump. The solvent was concentrated and analysed for DDT content by gas chromatography. The method of analysis is capable of detecting less than 50 ppb. of DDT in the air. No DDT was found in the collected sample, which suggests that serious volatile loss of chemical did not occur in the period from 48 to 60 hours after spraying of the Vance Creek Unit.

DISCUSSION AND CONCLUSIONS

Analysis of surveillance reports showed few visible adverse effects of the spray project on non-target biota. Some aquatic insect mortality occurred when a large amount of DDT was released directly into a stream. This occurred where the insecticide reached water after the accidental loss and might have occurred at Vance Creek following a heavy rainstorm. The deaths of a few fish might have been caused by DDT at Vance Creek, but live fish were recovered from the same net at the same time. Both live and dead fish contained similar levels of DDT residues.

According to W. M. Morton, Bureau of Sport Fisheries and Wildlife,

"from our surveillance of the Burns Project, and similar pesticide programs, there seems to be no need to modify present operating procedures to protect fish and wildlife. It has been our general observation in the West that practically all Federal agencies that apply small quantities of pesticides over large areas have made it their policy to consult the State Fish and Game Departments before spraying and to take all possible precautions to avoid getting any of the chemical into streams and lakes. As a result, we have had no known serious fish mortality in this area in the past several years that could be ascribed to Federal pesticide application."

Levels of DDT in big game, cows, and forage followed patterns similar to those that have been observed during other spray projects. Residue increased from relatively low prespray readings to their highest levels soon after spraying and then declined to near prespray values within a year or less after treatment.

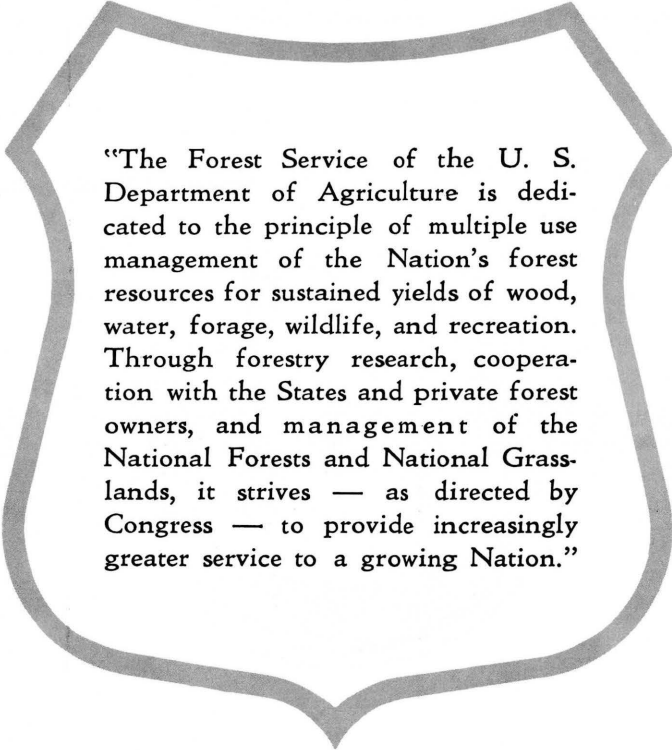
Admittedly, we have no way of determining what subtle effects the insecticide may have had on other

environmental components. Insecticide usage always carries certain unpredictable risks since few, if any, effective toxicants are wholly selective. Thus, recommendations for insecticide applications must be made only after it has been determined that no other action can be taken to halt an insect buildup.

The decision to apply DDT on the Malheur National Forest was made after intensive investigations indicated that severe losses would be inflicted on timber resources and therefore the economic well-being of the region if the tussock moth outbreak was not controlled. Every possible effort was made to insure that the insecticide was applied only where needed. Project costs were increased substantially by spraying with helicopters. Using fixed-wing aircraft would have been less expensive, but precision spraying could not have been attained.

During surveillance planning it became evident that few, if any, public agencies have the fiscal and manpower flexibility to conduct comprehensive surveillance assignments on large-scale pesticide projects, especially on short notice. Therefore, it was encouraging to learn that the Bureau of Sport Fisheries and Wildlife has, since the Burns Project was completed, added responsibilities for surveillance of Federal pesticide projects to the activities of their Division of Fishery Services and Division of Wildlife Services. This action should expedite, and perhaps standardize, surveillance of future pest control projects on wildlands.

Finally, the major value of the surveillance effort may have been to inform operations personnel of the potential hazards of aerially spraying and to constantly remind them of their responsibility to avoid unnecessary environmental contamination.



"The Forest Service of the U. S. Department of Agriculture is dedicated to the principle of multiple use management of the Nation's forest resources for sustained yields of wood, water, forage, wildlife, and recreation. Through forestry research, cooperation with the States and private forest owners, and management of the National Forests and National Grasslands, it strives — as directed by Congress — to provide increasingly greater service to a growing Nation."

